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RESEARCH ORDER #14, PHASE 3

SIX INTERCOMMUNICATION SYSTEMS

50X1

PROJECT 3098

JULY 14, 1955

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diagrams

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I. Introduction

On July 14th, delivery of six developmental model Portable Intercommunication Systems was completed. The following is a report on the construction, operation, and maintenance of these systems.

II. Description

The Portable Intercommunication system consists of two units; a frequency-modulated transmitter called the "Listen" Station, and a receiver called the "Talk" Station.

The "Listen" Station is housed in a phenolic box 2 11/32" X 3 5/16" X 11 1/8". It consists of an FM transmitter tuned to 120 kilocycles and a control receiver which activates the transmitter when a 75 kilocycle carrier is received. The output of the transmitter and input to the receiver may be connected to 60 cycle power lines, or the carriers may be transmitted and received through lines connected to two terminals on the housing. The unit may be used on 115 volt or 230 volt 50 or 60 cycle power lines.

The "Talk" Station is housed in a steel box 3 11/32" X 4 7/32" X 10 3/4". It consists of an FM receiver tuned to 120 kilocycles and a control transmitter tuned to 75 kilocycles. The output of the transmitter and the input to the receiver may be connected to the power line, or external lines connected to the terminals at the rear of the unit may be used. The unit may be powered by 115 volts or 230 volts AC, 50 or 60 cycles.

III. Theory of Operation

A. "Listen" Station

The "Listen" Station consists of six sub-assemblies; power supply, microphone, audio amplifier, RF section, filter, and control receiver. The audio amplifier, RF section, and control receiver components are wired on printed circuit chassis. These three sub-assemblies and the 75 kilocycle filter are mounted on another printed circuit board.

The power supply occupies approximately four inches of length at one end of the housing. The components are mounted on one side and one end of the housing. A transformer is used for the tube filaments in the transmitter portion of the unit. The transformer has two primary windings which are connected in parallel for 115 volt operation and in series when used on 230 volts. The primary also acts as an auto-transformer for 230 volt operation stepping down the line voltage to 115 volts before it is rectified to obtain B+ voltage.

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A selenium rectifier connected in a half wave rectifier circuit provides the B+ voltage. An R-C filter is used to remove 60 cycle ripple. A tapped bleeder provides lower B+ voltages for the transistors in the unit.

Part of the current from the 6.3 volt secondary winding of the transformer is rectified by four germanium junction type diodes connected in a bridge circuit. The resulting DC is dropped and filtered by an R-C filter. This current is used for the filaments of the 1AD4 tubes used in the transmitter. The remainder of the current heats the 6.3 volt filament of the 5703 output tube.

The microphone is a modified commercial ceramic unit. A transistor is connected in a grounded collector circuit and is mounted inside the microphone case. This provides impedance transformation to reduce the high impedance at the ceramic microphone cartridge terminals to approximately 1000 ohms. The microphone cord carries the audio to the unit and provides the DC to the transistor in the microphone case.

The audio amplifier sub-assembly consists of three transistor stages mounted on a printed circuit chassis. The three stages are R-C coupled. The last stage will clip the audio signal, preventing over-deviation, if a high level audio signal is received by the microphone. The collector load of the last stage is tapped to provide approximately one volt of audio voltage to the modulator when clipping occurs. A volume control is connected between the first and second stages. This potentiometer will determine the audio level into the microphone necessary to cause clipping in the final audio stage.

The RF sub-assembly contains four tubes. A reactance tube modulator is connected across the tank of a Hartley oscillator connected as an electron coupled oscillator operating at 120 kilocycles. The output of the oscillator is R-C coupled from the plate to the grid of the driver tube. The plate of the driver tube is tuned, and the output is capacitance coupled to the grid of the final power amplifier tube. The plate of the final is tuned, and two secondaries are coupled to the final plate tank. One secondary is wound to match an impedance of approximately 500 ohms. This winding is connected to the terminals on the housing with a 0.1 micro-farad capacitor in series with one side of the winding.

The other secondary winding has one side grounded and the other side connected through a 0.1 micro-farad capacitor and a single pole single throw switch to the power line. The input of the

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be placed in the terminal position (handle toward the terminals). The same procedure used for turning the "Listen" Station on under power line carrier operation applies to external line operation.

C. 115 Volt to 230 Volt Conversion

The systems delivered were adjusted to be used on 115 V. AC lines. In order to use a system on 230 volt lines one change in each unit must be made. On one end of the "Listen" Station the switch marked "115 volts-230 volts" should be moved to the 230 volts position. In the "Talk" Station the line voltage conversion switch is located on the chassis. It is approximately in the center of the chassis between the filament transformer and the filter. Its handle is on top of the chassis. To convert the unit for use on 230 volt power lines, the handle should be moved toward the right side of the chassis. These are the only changes needed for 115 volt to 230 volt conversion, and the procedure is the same for power line carrier or external line use.

V. Maintenance

A. Tuning

1. "Listen" Station

In the "Listen" Station three tuning adjustments can be made on the RF sub-assembly. The control receiver is permanently tuned.

Before any tuning adjustments are made, the housing must be opened. First, the top panel (the large side with the hole for audio volume adjustment) and one side panel (the long narrow side without large screw heads on it) should be removed from the rest of the housing by removing all the small screws holding these two sides. Then the power supply should be separated from the rest of the unit by removing the small screws holding the remaining long narrow side and the end panel of the housing on which the terminals are fastened. Leaving the nine pin plug in its socket on the power supply and the red shielded lead attached to the terminal strip in the power supply, turn the unit composed of all the sub-assemblies attached to the long narrow side of the housing over. Remove the relay from its socket and short out pins 2 and 3 with a short wire jumper.

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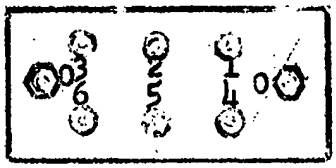
Side Nearest Power Supply



Relay Socket, Top View

When the relay is replaced it must be placed in the socket with the orange dot adjacent to the outside edge of the unit.

The slugs tuning the three coils on the RF sub-assembly are accessible through holes in the shield can covering the sub-assembly.

All slugs are locked in place with wax. To loosen them, heat them with a heat lamp until the wax has softened enough to allow the slugs to turn.

To tune this section, an AC, V.T.V.M. (Hewlett-Packard 400C or equivalent) should be used to measure the RF voltage at the terminals. To measure the frequency, a frequency meter or counter may be coupled to the same terminals, or the frequency can be compared with a calibrated signal generator using an oscilloscope to obtain a Lissajou figure.

The frequency of the transmitter section is adjusted by tuning the slug through the hole located nearest the right edge of the shield can. This slug should be adjusted until the frequency is 120 kilocycles.

The slug nearest the top of the can tunes the driver plate. It should be tuned for maximum reading on the AC V.T.V.M. The remaining slug tunes the power amplifier tank. It, too, should be tuned for maximum terminal voltage (20-30 V.).

2. "Talk" Station

To tune the coils in the "Talk" Station, the chassis must be removed from the housing. First remove the volume control knob and the front panel containing the speaker grill. Next remove the four screws on the bottom of the housing. The chassis can now be removed. All the slugs

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in the "Talk" Station are also locked with wax and must be loosened by applying heat with a heat lamp. Most of the selectivity for the voice modulated carrier receiver is in the permanently tuned filter.

To re-peak the coils, a source of 120 kilocycles should be coupled to the power line. The "Talk" Station should be plugged into the same power line and connected for power line carrier operation. A listen station can be used as a source of 120 kilocycles if the audio gain control is turned down all the way (counter-clockwise).

The first tuning adjustment is the coil in the collector of the last transistor amplifier. With the DC probe of a V.T.V.M. connected to the grid (pin 1) of the limiter tube through a 1 megohm resistor, tune this coil for maximum reading on the meter (10-20 V.). The limiter tube is a 6AU6, and it is the second tube back from the front of the unit.

The primary of the discriminator transformer should be tuned next. Connect the DC probe of the voltmeter to the "discriminator overall" test point which is pin five on the coil base of the coil directly behind the speaker. Tune the slug accessible through the hole on top of the shield covering this coil until the meter reads maximum voltage (35-50 V.).

Tune the secondary of the discriminator transformer for zero voltage at the "discriminator zero" test point. This point is located beneath the chassis at the left edge of the chassis directly behind the left earphone jack. Attached to this point are one of the discriminator diodes, a 390K ohm resistor and a 200 micro-micro-farad capacitor. Adjust the slug accessible through the hole in the coil base on the bottom of the chassis until zero voltage is read at this point with the V.T.V.M.-DC probe.

The control transmitter located at the rear of the talk station chassis should be tuned next. The unit should be left connected as a power line carrier receiver, but the source of 120 kilocycle carrier should be removed from the power line. An AC V.T.V.M. and a device to measure the frequency of the transmitter (counter, frequency meter, or oscilloscope) should be connected to the terminals.

The frequency of the control transmitter oscillator is varied by adjusting the slug in the coil located directly

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behind the filament transformer. This slug should be adjusted until the frequency of the control transmitter is 75 kilocycles.

The slug in the coil nearest the end of the chassis should be tuned next until maximum voltage is read on the AC V.T.V.M. (25-35 V.).

B. Miscellaneous

If the system is being used as a power line carrier intercom, and the "Listen" Station turns on when no carrier is present on the lines, the sensitivity of the control receiver may have to be reduced.

Approximately on the center of the control receiver printed circuit chassis there are two 27000 ohm 1/4 watt resistors. To reduce the sensitivity of the receiver the value of the resistor nearest the top edge of the stage should be reduced to 10,000 ohms.

Components may be removed from printed circuit boards by applying a soldering iron on the printed wiring where the component lead enters the board. At the same time, the end of the component being heated should be lifted away from the board.

If a transistor is being removed from or soldered to a printed circuit chassis, each lead being soldered should be held securely with a long nose pliers providing a heat sink between the area being soldered and the transistor.

VI. Conclusions

The system described will fulfill the requirements for a power line carrier system comparable to commercial wireless intercoms. The biggest improvement that could be made in this system would be replacing the tubes used in the listen station with transistors. The advantages of a transistorized transmitter would be smaller size, greater efficiency less complicated power supply, greater reliability, and longer life. Due to the higher efficiency of transistors, the unit would have less power consumption during either stand-by or full operation. The power supply would also be more efficient because resistor dividers would not be necessary to secure the many voltages now needed. This overall increase in efficiency of the unit would cause less heat to be generated by the unit for the same performance the unit now has.

At the present time, high power (one watt or more) high frequency transistors are still in development. Since such a transistor is the only thing lacking in order to make a transistorized "Listen" Station possible, development on such a system can start in the near future.

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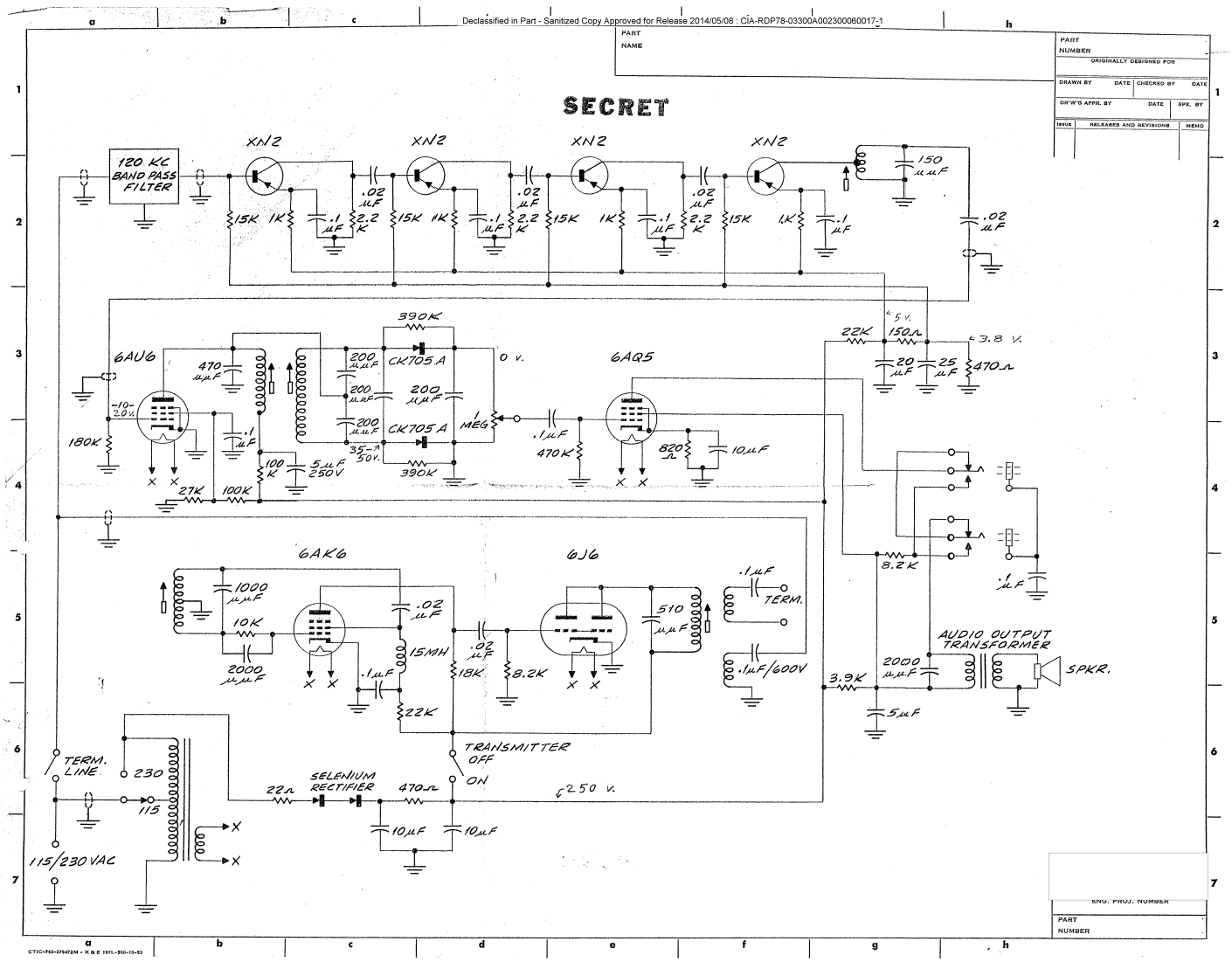

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